1.0 INTRODUCTION

Ice has been used as a structural material for construction in the Arctic for many decades, for roads, airstrips and in oil and gas exploration. The first ice islands for oil and gas exploration were built in the early 1970s by flooding with seawater to thicken existing ice until it grounded and provided sufficient freeboard. Floating flooded ice islands were also constructed for use in deep water. Techniques were subsequently developed which led to the use of sprinkling and spraying to form ice islands. However, many of these programs were terminated with the downturn in the industry in the 1980s.

Renewed interest in exploiting offshore gas reserves in the arctic has led to a need to expand on the knowledge gained over the past 30 years. The objectives of this project are to identify current state of the art practice in the design, construction and use of ice islands for offshore exploratory drilling. This will be followed by identification of areas in which future research efforts may be directed in order to increase the efficiency of construction and maintenance of offshore ice islands.

SCOPE OF WORK

The first stage of the project has been to assimilation all the available research, design, construction and maintenance history of ice islands. Much of the corporate knowledge and experience from previous work has now been lost, and so it is important to recapture this from individuals that have been involved and from archived reports of ice island operation. This work has been brought up to date and used to identify current state-of-practice in the industry, in particular using recent experience in the North American Arctic, as well as other geographic areas such as Russia and the Caspian Sea.

Information relating to research, design, construction and maintenance of ice islands is being collated from a number of sources:

- The principal source of data is from archived reports located in the offices of Sandwell Engineering in Calgary. These include numerous reports relating to the design, verification and monitoring of ice structures in the arctic. Table 1 lists the main reports being consulted as part of this element of the project. Further data is being obtained from design reports on the Panarctic floating ice islands of the Canadian high arctic from the 1970s and 1980s. A summary report has been commissioned from Sandwell Engineering to capture this information.
- Three grounded spray ice islands were constructed and used for exploratory drilling in Harrison Bay, Alaska in the winter of 2003. Design and monitoring was undertaken by Sandwell Engineering and their client, Pioneer Natural Resources has agreed to allow this data to be reported for use in this study. A report on the design, construction and performance monitoring of the islands has been commissioned from Sandwell Engineering for inclusion in the project.
- Information held in the C-CORE Information Centre, St John's and Arctic Science & Technology Information Service (ASTIS), University of Calgary,

includes both published and unpublished reports on a number of past projects related to ice islands. ASTIS, in particular contains numerous reports donated by petroleum companies and this source of information is being exploited.

Information from the sources detailed above are being summarised into a database for ease of access and further analysis. The database is being created in 3 parts in order to capture the relevant common information for each section:

- Spray Ice Projects – Details of past spray ice operational or experimental experience, including where available, details of design and construction parameters and results of performance monitoring. Data from a number of sources is being amalgamated to provide a more complete data set than available from any individual source. Although the focus is on ice islands, other structures using the same technology is being used, for example ice roads, protection structures and port facilities.
- Flooded Ice Projects – Similar to the database for spray ice projects, with the selection of appropriate parameters.
- Ice Properties – Design and measured ice properties from a range of sources for tests performed on snow, natural ice and man-made ice structures. The test data includes both in-situ and laboratory testing of a range of material types. The test parameters being studied specifically include the interrelationship of strength, stiffness, density, temperature and construction technique for man-made ice.

Analysis of the database will allow trends to be assessed and potential improvements to be quantified as a function of construction technique and material properties.

The identification of potential advances through focused research will allow cost efficient design, construction and maintenance of ice islands for use in offshore oil and gas activity. A demonstration centrifuge model test was also conducted to quantify the effects of sliding resistance of a spray ice island and compare with existing design assumptions. Centrifuge modeling has potential in evaluating the operational behaviour of ice islands under specific loading conditions.

Figures 1 presents the typical geometry for a grounded ice island, and Figure 2 shows the Mars ice island constructed by Amoco offshore Alaska.

Report Title	Author(s)	Report Date
SSDC Bow Rubble Generator Ice Island Construction	D.M. Masterson	1984/09/28
SSDC Bow Rubble Generator In-Situ/Lab Strength Measurements of Sprayed ice	J. Kenny, R. Gamble, T. Smith	1984/09/28
Panarctic Proposal for 1984-85 Ice Platforms	D.M. Masterson	1984/07/13
Offshore Drilling Ice Platform, Buckingham O-68	J. Kenny and B. Lynch	1984/11/20
Creep and Relaxation Behaviour of Ice Platforms	B. Sowdaey and J. Kenny	1984/12/28
Freezing Mechanics of Seawater Spray		1984/05/01
Freezing Mechanics of Seawater Spray		1984/05/01
Spray Ice Island, Preliminary Data Package	R. Gamble and K. Been	1985/04/01
Spray Ice Island, Preliminary Data Package	R. Gamble and K. Been	1985/04/01
Spray Ice Island, Report on Construction, Testing and Monitoring		1985/07/01
Spray Ice Island, Report on Construction, Testing and Monitoring		1985/07/01
Construction, Testing & Monitoring of Spray Ice Island - Main Report		1985/09/01
Construction, Testing & Monitoring of Spray Ice Island - Main Report		1985/09/01
Construction Testing & Monitoring Spray Ice Island Appendices		1985/09/01
Construction Testing & Monitoring Spray Ice Island Appendices		1985/09/01
Mars Ice Island Report, Appendices B, C, D, E and F		1986/06/01
Thermal Analysis, Sprayed Ice Platform		1985/12/01
Global and Local Load Deflections - Cape Allison C-47	D.M. Masterson	1985/12/17
Offshore Drilling Ice Platform, Cape Allison C-47 TOC	M. Bourns	1986/03/01
Offshore Drilling Ice Platform, Cape Allison C-47 Project Report	B. Lynch, M. Bourns and A. Pare	1986/03/01
Offshore Drilling Ice Platform, Cape Allison C-47 - Main Report and Appendices A - F	B. Lynch, M. Bourns and A. Pare	1986/03/01
Offshore Drilling Ice Platform, Cape Allison C-47 - Appendix G	B. Lynch, M. Bourns and A. Pare	1986/03/01
Offshore Drilling Ice Platform, North Buckingham L-71		1986/04/01
Offshore Drilling Ice Platform, West Cornwall N-49		1986/04/01
Analysis and Design of Floating Spray Ice Platforms		1986/05/01
Ice Island Construction	R. Gamble	1984/08/01
Marguerite Lk. Ice Platforms Design Report	T. Smith	1986/02/04
Marguerite Lk. Ice Platforms Final Report	T. Smith	1986/04/01
Design Basis of Chevron Karluk Prospect King Spray Ice Island.		1988/11/01
Karluk Ice Island Construction Methodology - Draft		1988/11/01

Table 1: Summary of reports being used in data collation

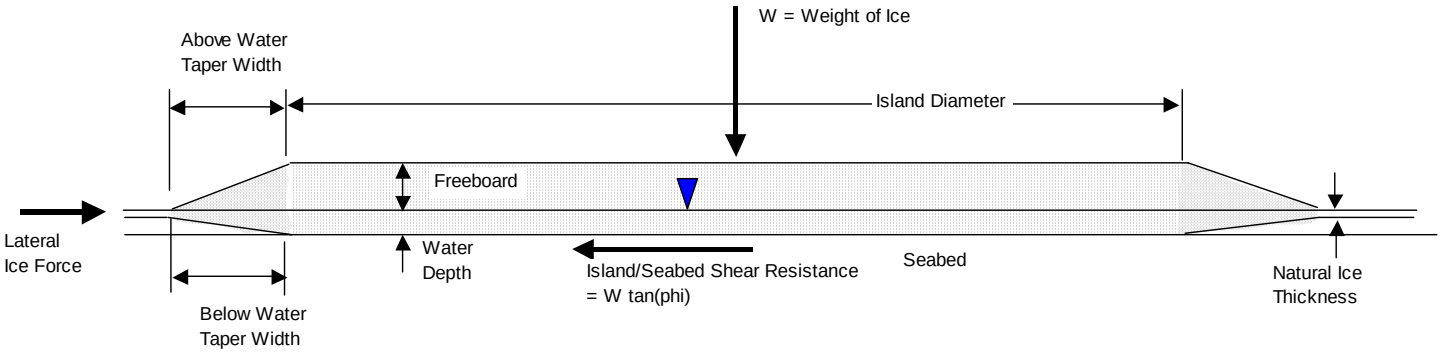

Figure 1: Typical ice island geometry

Figure 2: Mars Spray Ice Island. Offshore Alaska